Light and Lighting

Official Journal of the Illuminating Engineering Society.

Incorporating "The Illuminating Engineer."

32, Victoria St., London, S.W.1.

Edited by J. STEWART DOW

Telephone: ABBey 5215

Vol. XXXVIII.—No. 5 May, 1945 PRICE NINEPENCE Subscription 10/6 per annum, post free

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V-Day

THE coming of V-Day and the end of hostilities in Europe makes May, 1945, a month to be remembered.

Gratitude for Deliverance does not bring with it forgetfulness of the difficulties ahead. Removal of restrictions and limitations may come slowly. Years may pass before a period of plenty is attained again.

Yet, after the endurances of nearly six years of warfare to an issue which seems still a miracle, scarcely conceivable in the dark days of 1940, we may well go forward with high hopes for the future.

Freedom in the lighting field is as yet only partially restored and for some time to come desire may outrun performance. Yet we would urge I.E.S. members and those in the lighting industry to plan with confidence, to be prepared if necessary to take some risks in order to make this year of peace a memorable one—something to look back upon with pride and satisfaction in time to come.

I.E.S. Annual Meeting

The I.E.S. annual general meeting on May 15 followed very shortly after the termination of hostilities. Members, with V-Day still in mind, listened appreciatively to the opening remarks of the President (Mr. E. Stroud) recording grateful recognition of this great event and expressing high hopes for the future. In this connection the annual report of the Council makes encouraging reading. It records another great advance in membership, and the formation of new Centres and Groups, two of which (in Edinburgh and Liverpool) have already qualified for Centre Status. For the first time an analysis of the complete membership, already approaching 1,700 at the end of 1944, is presented. From this it is evident how materially the formation of new groups helps the growth of membership. Mere numbers, however, do not tell the whole story. There is good evidence that the addition of members has brought with it plenty of new talent. A good indication is the array of meetings now being held throughout the country—over 100 in 1944, and more than double the greatest number held in pre-war days. With the coming of peace attention can be concentrated on the full restoration of pre-war activities and the introduction of new developments. These, we may be sure, will be apparent in the coming session. In such new efforts the Society should be aided by the increased revenue resulting from the changes in subscription sanctioned by members last year—which seem to have had imposed no check on membership, and by the extension of headquarters' administration which the Council has in mind. It was announced at the annual meeting that one important step in this direction had already been taken—the appointment as Secretary of Mr. Raymond Pye, the Honorary Secretary of the Leeds Centre, who will bring with him the good wishes of all members when he enters on his new duties.

In the course of the proceedings the President announced the Officers and Members of Council for the coming session. We feel sure that members generally will applaud the choice, for the next President, of Mr. H. C. Weston, who has done so much valuable pioneering research work, more especially in the study of factors which form the scientific background of the I.E.S. Code.

Following the transaction of formal business an address on "Daylight and its Penetration into Sea Water" was delivered by Dr. W. R. G. Atkins, O.B.E., F.R.S.—a fascinating account of an unusual field of knowledge. Once more the policy of going out of the beaten track for such addresses was fully justified.

I.E.S. Officers and Council

It was announced at the annual general meeting of the Illuminating Engineering Society that the new officers and members of Council elected for the coming session, which will commence on October 1, 1945, are as follows:—

President: Mr. H. C. Weston.
Vice-Presidents: Mr. Howard Long, Mr. H. E. Chasteney, and Mr. J. M. Waldram.
Hon. Treasurer: Mr. N. V. Everton.
Hon. Secretary: Mr. J. S. Dow.
Members of Council: Mr. J. N. Aldington, Mr. M. G. Bennett, Dr. W. M. Hampton, Mr. A. G. Higgins, Mr. J. S. Preston, Mr. A. J. Pashler, Mr. E. B. Sawyer, Dr. W. S. Stiles, Dr. W. D. Wright.

In addition, as mentioned elsewhere, the Council has appointed Mr. Raymond Pye (hon. secretary of the Leeds Centre) as secretary. It is hoped that Mr. Pye will enter upon his duties in July.

A.P.L.E.: Forthcoming Conference in Glasgow

We note with interest the announcement that the Association of Public Lighting Engineers will be holding its annual meeting and conference in Glasgow during September 11-13. An interesting series of papers dealing with various phases of street lighting will be presented and an exhibition of street lighting apparatus and equipment is being arranged by the Public Lighting Dept. of the City of Glasgow. Delegates from local authorities are being invited, as in previous years. Although the Association, with commendable enterprise, arranged a gathering in London in 1943, this coming conference is the first full-scale event to be organised since the outbreak of war. It will doubtless excite great interest amongst all concerned with public lighting. Further particulars may be obtained from the secretary of the Association (Mr. H. O. Davies, 68, Victoria-st., London, S.W.1).

S.I.M.A.: Bowen Prizes for 1945

It is announced that Mr. W. Bowen has generously presented to the Scientific Instrument Manufacturers' Association of Great Britain a substantial capital sum, the income of which is to be devoted towards the encouragement of invention, design, and research. Under the Deed of Trust the Council of the S.I.M.A. will award, for the current year, five prizes of £25 each for (a) a new invention, (b) an improvement in design, (c) an improvement in manufacturing technique, or (d) a new development or new process arising from research. The subject matter on which descriptions or papers are to be based includes microscopes, binoculars, telescopes, etc.; nautical, aeronautical, and survey apparatus; industrial precision instruments; laboratory research and medical apparatus; ophthalmic lenses. The competition is open to all employees or members of the S.I.M.A. All papers must be submitted before December 31, 1945, to the secretaries, Messrs. Binder, Hamlyn and Co., River Plate House, 12-13, South-place, London, E.C.2, from whom fuller particulars may be obtained.

"Making Work Lighter"

There has been a brisk demand for the above booklet on industrial lighting, effectively illustrated by sketches in colour by Fougasse, but readers are reminded that copies (price 6d. each) are still available from the I.E.S. This, it will be recalled, is the sixth of the Lighting Reconstruction Series. Nos. 1-5 are also obtainable, at a uniform rate (1s. each, 9s. per dozen, £5 per 100), on application to the Illuminating Engineering Society (32, Victoria-st., London, S.W.1).

The Technical Press

A useful memorandum issued by the Council of the Trade and Technical Press emphasises the collective importance of the technical and trade Press—of which, it is feared, official circles are not fully aware.

Technical journals deal with scientfic progress and improvements in design, materials, equipment, and production the world over. Although the circulation of a highly technical journal may appear small, not a single one of its readers can afford to be without the information it contains. Collectively, therefore, technical journals constitute a potentially most valuable element at the present time, in relation to the switchover from wartime to peaceful production and the development of export trade.

Yet to-day the technical and trade Press finds itself in an unenviable position. For upwards of three years it has been carrying on with a basic paper ration of one-fifth of pre-war consumption. Quality of paper has also deteriorated very seriously. Journals have been driven to adopt paper of much lighter weight and giving a smaller page than would have been used for choice—with adverse effects on technical illustrations. The contrast is great with similar journals in the U.S.A., a number of which have grown substantially in size during the war.

The memorandum concludes with a statement of what is required from the Government. Amongst these needs are (1) additional paper of a quality which will stand comparison with that used by competitive journals abroad, (2) the early release of skilled operatives for the manufacture of high-grade paper, for printing and for block making, (3) the early release of experienced technical and trade key men to supplement editorial staffs, (4) a high priority for the provision of new and up-to-date printing machinery, and (5) the release of full information of the many new discoveries and inventions that British scientific research has evolved and British technical skill developed during the war.

Lectures for School Children

The Christmas lectures for children, arranged originally in Bradford and subsequently given in London and elsewhere, proved very acceptable. No doubt the plan will be extended. There are, however, certain drawbacks to the Christmas scheme. Teachers and schoolchildren are on holiday, weather uncertain, and attendances difficult to estimate. Hiring of special halls may prove difficult and expensive and the transport of apparatus at that season rather an effort. From the general I.E.S. standpoint it is evident that Christmas lectures of this kind arranged at *all* Centres would involve considerable expenditure. It is interesting, therefore, to note the alternative plan adopted by the Newcastle Centre whereby lectures were given in schoolrooms, during term time, in a number of schools—with excellent results. This plan has distinct advantages. It ensures attendances, puts less burden on lecturers and teachers, and involves no special hiring of halls. It is probable, certainly, that arrangements for demonstrations might have to be less elaborate, but this is not necessarily a drawback. A great deal can be done with simple devices—especially if arrangements could be made for lecturers to put their heads together, swap ideas, and agree on a common syllabus, and concentrate on the simplification of apparatus.

The Avoidance of Glare

A review of Data Basic to Code Rules

by J. B. CARNE

(In what follows we give a summary of a paper given before the I.E.S. Sheffield Centre on March 5th, 1945. Mr. Carne has prepared a very useful summary of data rarely assembled in a concise and accessible form, and we are therefore giving exceptional space to this particular contribution.)

The anticipated publication in the near future of codes of practice concerning interior lighting makes opportune a review of data relevant to the formulation of recommendations aimed at the avoidance of excessive glare.

Since such codes are concerned with levels of illumination which produce brightnesses ranging from 0.1 e.f.c. to 100 e.f.c., considerations may be confined to information relating to the eye when photopically adapted.

Before setting down the pertinent quantitative data on cause and effect of glare, three statements of a qualitative character made early in the century are worthy of note.

Effect of Glare on Visual Acuity.

In 1900, Uthoff and Dépène (1) concluded the following, as a result of a study of the effect upon visual acuity of a light source at various angles to one side of the visual axis:—

Depression of vision was

(a) *less* for a greater angle between glare source and visual axis.
(b) *greater*, the greater the intensity of the glare source.
(c) *less*, the greater the intensity of illumination of the test object.

Further (d), with high intensity of illumination of the test object, a side light source of low intensity produced increase in acuity.

Dazzle and Discomfort.

Sweet (2) (1910) concluded that "glare" included two separate and independent phenomena, namely:—

(1) The "blinding" effect, which is a factor dependent on (a) candle power, (b) angle of vision from the direction of the glare source, (c) distance of glare source from the eye, and is independent of brilliancy of glare source.

(2) The "ocular" discomfort, dependent on brilliancy of glare source, and its contrast with its surroundings.

In 1915 a committee on glare, appointed by the American I.E.S. (3), reported:—

> "That while the effect of a glare source upon visibility ceases when the source is removed 25° to 30° from the visual axis, the ocular discomfort persists as long as the source remains in the field of view."

The last two statements, it will be observed, discriminate between disability glare and discomfort glare, a discrimination which subsequent scientific work supports.

Brightness Level of Adaptation and M.P.B.D.

Holladay (4) (5), in 1925, carried out a comprehensive investigation into the effect of glare sources on the brightness sensitivity of the eye. As a criterion of

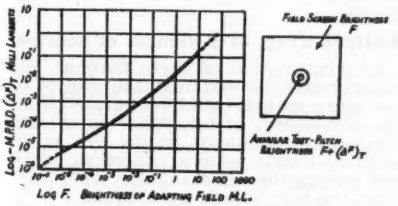


Fig. 1. Increase of M.P.B.D. with Adapting Field Brightness (Holladay)

brightness sensitivity he adopted the minimum brightness difference which the eye could perceive in an otherwise uniformly bright field. The greater this Minimum Perceptible Brightness Difference the less is the corresponding sensitivity of the eye. Thus the reciprocal of the M.P.B.D. may be taken as a measure of the absolute sensitivity.

The curve in Fig. 1 shows the direct proportionality between the M.P.B.D. and the brightness of the uniform field to which the eye is adapted, no glare source being present.

In Fig. 2 the curves show the direct proportionality between the M.P.B.D. and the illumination at the eye due to the glare sources for given angles of separation. Curves at a and b relate to the same pattern test object, with angles of separation between the glare source and the direction of vision of 5° and 10°

respectively, whilst curve c relates to a test object of different pattern and 10° 6′ angle of separation.

Holladay found that the M.P.B.D. for a given glare source at given angular

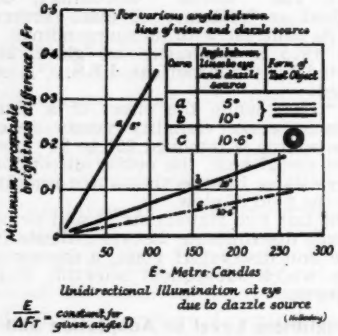


Fig. 2. Variation of minimum perceptible brightness difference with illumination at eye due to dazzle source.

separation was the same for all positions of the glare source relative to the test object.

Additive Effect of a Number of Sources.

In confirmation of these findings, his experiments showed that the effects of two glare sources equally separated from the test object and together producing the same illumination at the eye as an annular dazzle source concentric with and having the same angular separation from the test object, were equal.

Influence of Brightness and Dimensions of Dazzle Source.

Holladay concluded from experimental evidence that the obscuring effect per unit of illumination at the eye, as measured by the M.P.B.D., is independent of the brightness and dimensions of the radiating or diffusing surface of the dazzle source.

The Variation of Glare with Angular Separation and the Brightness Sensitivity of the Retina.

The curve of Fig. 3 shows the increase in the glare effect with decrease of the angular separation between the glare source and the direction of vision. The depression in brightness sensitivity is here evaluated as the uniform field brightness which effects the same M.P.B.D. as that resulting from the glare source.

It is not without interest to note the

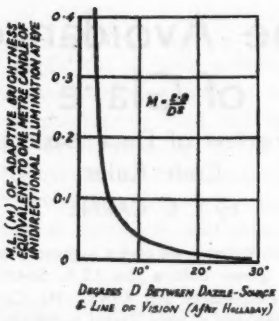

M.L. (M) OF ADAPTIVE BRIGHTNESS EQUIVALENT TO ONE METRE CANDLE OF UNIDIRECTIONAL ILLUMINATION AT EYE
M = E·D²
Degrees D Between Dazzle-Source & Line of Vision (After Holladay)

Fig. 3. Equivalent adaptive brightness due to dazzle source at various angles.

similarity of this curve to the corresponding portion of that in Fig 4 (6) relating the response of the eye to the same light patch incident on the retina at various distances from the fovea.

Whatever the mechanism of interference of vision by a glare source, it seems not unreasonable to expect that there will be a correspondence between the degree of interference and the characteristic sensitivity of the retina.

Effect of Brightness of Background.

Lythgoe (7), using as a measure of visual acuity the minimum angle visually separable, has also shown that when the brightness of the surround is nearly equal to that of the test object the acuity begins to diminish, and falls when the surround is brighter than the test object. The curve of Fig. 5 relating to a test object brightness of 12.6 e.f.c. shows that increase in the surround

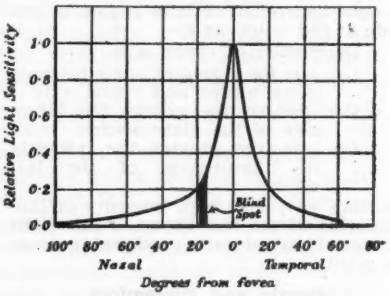


Fig. 4. Variation of Light sensitivity across retina for photopic eye. (After Dr. W. D. Wright.) [Data only approximate].

brightness above approximately 6 e.f.c. results in a decrease in acuity.

As stated previously, a light source may

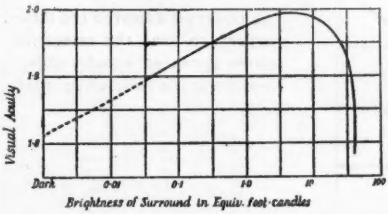


Fig. 5. Variation of acuity with surround illumination. Brightness of test object 12.6 e.f.c. (Lythgoe).

cause *discomfort*, even though it has ceased to be disabling to vision.

Brightness of Glare Source

A feature which distinguishes discomfort glare from disability glare appears to be the independent rôle which the brightness of a glare source plays in the case of the former. The series of curves shown in Fig. 6, based on the results of Holladay (5), indicate that the limit of tolerable brightness at

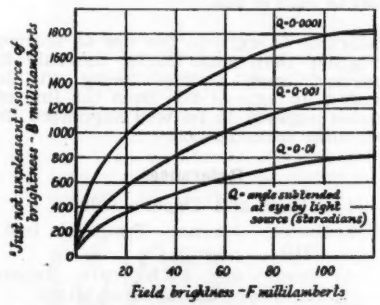


Fig. 6. Simultaneous discomfort glare. The relation of brightness B of light source to its background F for equal psycho-physiological sensations deemed not unpleasant, for light sources subtending various angles at the eye. (After Holladay.)

various levels of adaptation is a function of the brightness of the glare source and is not proportional to the illumination received at the eye from the glare source. So far as conditions in interiors are concerned the parts of these curves up to 50 milli-lamberts field brightness may be applicable, since walls and ceilings of this brightness would produce a horizontal illumination of 50 ft.c., which may be taken as the maximum likely to be realised in practice from light reflected by the surrounds.

The inference to be drawn from the curves of Fig. 6, that the lower the brightness the more powerful is the source which can be tolerated, is confirmed by the results of an investigation by Ward-Harrison (8) on the equivalent glare sensation produced by some practical light sources.

Ward-Harrison's results and a diagrammatic sketch of his apparatus are seen in Fig. 7.

"Successive" Glare.

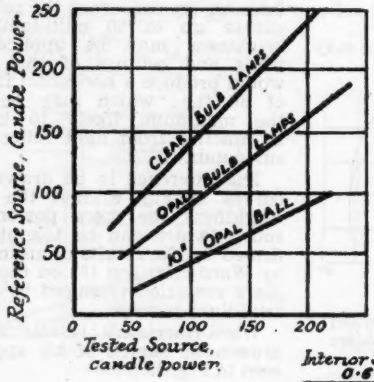
The foregoing refer to discomfort glare resulting from the simultaneous exposure of the eye to a general field and a glare source. Since practical conditions of vision involve the exposure of the eye successively to fields of view of unequal brightness, data on successive glare also require consideration. Nutting (9) recorded observation on the discomfort sensation resulting from sudden change in brightness of the visual field. Curves in Fig. 8 show his results. In this case the eye previously adapted to a given known brightness (adaptation level) is suddenly exposed to a field just bright enough to appear glaring. The brightness of this field is well above that regarded as perfectly tolerable under steady conditions of interior illumination.

A feature common to the curves of Figs. 6 and 8 is that the tolerable brightness increases at a slower rate than the adaptation brightness. Hence a rule based on a constant brightness contrast ratio would not accord with experimental observation.

Conclusions.

Numerous other data are available on the subject, but those selected and set down appear to the writer as the most pertinent to the formulation of practical working rules. Consideration of these selected data leads to the view that troublesome glare can be avoided by the limitation of the brightness of local areas to intensities depending on the brightness of the general field. This latter quantity might be assessed in terms of the intensity of indirect light reaching the horizontal plane.

The desirable limits may be based on



The observer adjusted the lamp current so that the reference source appeared equally objectionable as the lamp under test.

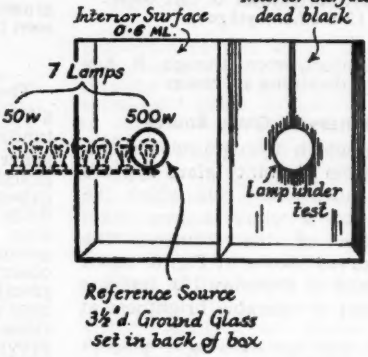


Fig. 7.
Discomfort glare comparisons. (Ward - Harrison, Trans. Ill. Eng. Soc., U.S.A., 1920.)

the results contained in Holladay's data on simultaneous discomfort glare. Where, however, it is not practicable or desirable to exclude the use of sources brighter than such limits, the rule to prevent such sources being visible within an agle of 20° from the line of vision appears to be well supported by scientific investigation.

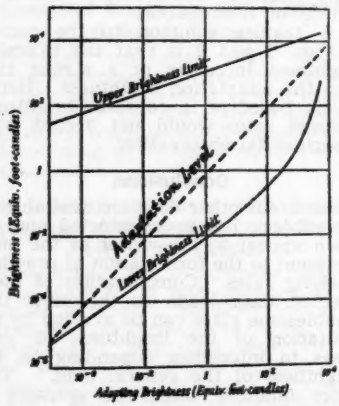


Fig. 8. Upper and lower brightness limits for various adaptation levels (Nutting).

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(1) Uthoff and Dépène, 1900.
(2) Sweet, Journal Franklin Inst., 1910.
(3) Trans. Am. I.E.S., 1916; Report No. 12 of Committee on Glare.
(4) L. L. Holladay, Journal Opt. Soc. Am., Vol. 12, 1926.
(5) L. L. Holladay, ibid., Vol. 14, 1927.
(6) W. D. Wright, "The Perception of Light," p. 5.
(7) R. J. Lythgoe, Med. Res. Council Special Report Ser. No. 173, 1932.
(8) Ward-Harrison, Trans. Am. I.E.S., 1920, p. 34.
(9) P. G. Nutting, Trans. Am. I.E.S., 1916, p. 939.

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INTO THE LIGHT...

ON and after July 15, 1945, normal peace-time street lighting may again be used.

Authorities are now advised by M.O.H.S. to restore their installations and to replace damaged equipment so that with the end of Double British Summer Time the streets will again be reasonably safe at night.

Production of Revo equipment is at present restricted, but nevertheless early inquiries are invited from Lighting Authorities as small quantities of vitally essential equipment can be supplied. Revo Lighting Specialists will gladly assist in the preparation of complete schemes.

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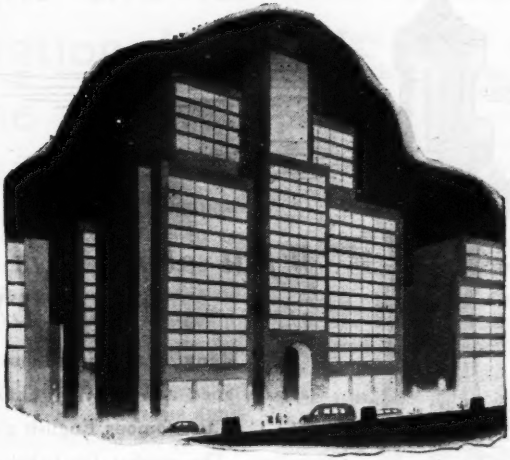

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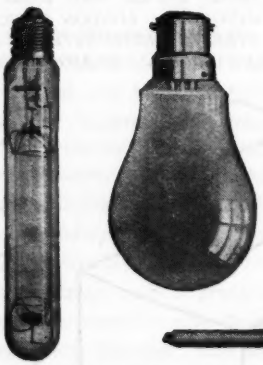

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Daylight and Its Penetration Into the Sea

A somewhat unusual field for consideration by illuminating engineers was covered in the address given by Dr. W. R. G. Atkins, O.B.E., F.R.S., to the Illuminating Engineering Society, following the annual general meeting on May 15. The address fell into three distinct sections, dealing respectively with photoelectric photometry, its application to the measurement of daylight and of light penetrating into sea water, and the effect of such light upon marine life, both vegetable and animal.

Photoelectric Photometry.

In his opening remarks, Dr. Atkins drew attention to the remarkable advance that has taken place in the sensitivity of photoelectric cells. The increase, in vacuum phototubes, has been over ten thousand fold, and with the selenium rectifier cell over one hundred thousand fold since the author and Dr. H. H. Poole took up the subject in 1924. Consideration must also be given to other qualities, for example, the approach to a linear relation between light-stimulus and response, and the comparative sensitivity throughout the spectrum. Very stable sodium and potassium cells are highly sensitive in the blue end of the spectrum; cells of greater sensitivity but lesser stability give their maximum response in the red. The selenium rectifier cell, however, has a spectral sensitivity curve similar to that of the eye, and can be brought to close accord to it with a green filter.

"Total Intensity" of Daylight.

In dealing with daylight, Dr. Atkins referred to measurements both in a vertical and a horizontal plane, and traced the variation according to the altitude of the sun. Of special interest is his apparatus to measure the "total intensity" received at a point by mounting over the photoelectric cell a hemispherical dome of diffusing glass. The reading is then independent of the altitude and azimuth of the source, except for diminution due to increasing atmospheric absorption as the sun declines. With a uniform sky the total intensity is twice that received on a horizontal surface, and four times that on a vertical surface.

Integrating Variable Illumination.

To integrate the illumination with respect to time, one may use the photoelectric current to deposit copper, or one may expose a flask of uranium oxalate and, by titration with permanganate, ascertain the amount decomposed. One may also, using a specially stable sodium cell, obtain a record with the Cambridge Instrument Company thread recorder and measure the area. This was done during 1940-41 at Plymouth. The yearly amount was closely the same for several years; of the total December yields about 1.25 per cent., and the brightest month (May, June, or July), about 16-17 per cent. Professor J. H. J. Poole also used a neon lamp circuit with a series of condensers to integrate variable illumination. By this means one can get the mean illumination under waving tree-tops in a wood, or just below the surface of the sea.

Submarine Measurements.

In order to obtain the submarine illumination, Dr. H. H. Poole measured the

drop in potential across a high resistance, using a null method with a "Meccano" clockwork interruptor and a telephone with amplifier to detect the point of balance. This was used at Plymouth and a model was installed in the U.S.A. research ship Atlantis. Determinations have been made of the extinction coefficient of sea water and its variations with depth, with locality and with season. Superimposed upon the true absorption of the water is the effect of scattering due to suspended particles. Very pure ocean water transmits best in the blue, coastal water in the blue green or green, but turbid estuarine water of high opacity may have its greatest transmission in the red.

Effect of Light on Marine Life.

The only source of energy for marine life is that supplied by the light entering and traversing the water. A fraction of this is absorbed by microscopic floating plants, diatoms and a minute amount by the shore algae. The multiplication of these diatoms is shown by the decrease in phosphate which is observed as the days lengthen, so that all phosphate is removed from the surface water, down to a depth limited by the illumination. Calculation from the amount of phosphate used up shows that in the English Channel 1,400 metric tons of vegetable matter is produced per square kilometre. Similar values are arrived at by calculating from the carbon dioxide and nitrogen compounds used up, but it is phosphate that primarily limits production, and where oceanic currents meet an island, such as S. Georgia, the deep water upwelling to a level of good illumination gives rise to a large crop. Plants, however, can have too much light, and by lowering pure cultures of a diatom Coscinodiscus, into the sea, it was shown by Miss Jenkins that optimum activity was exhibited at noon with the flash at 5 metres, and that only from 10 m. downwards was the production of oxygen closely proportional to the light energy. Russell, too, found that the depth at which freely floating animals were most abundant was regulated by the illumination.

Presentation to Sir Harry Railing

An interesting recent event was the presentation to Sir Harry Railing, on behalf of 400 members of the Institution of Electrical Engineers in the G.E.C., to commemorate his year as president. The presentation consisted of a silver cigarette casket and a book containing the signatures of subscribers inscribed in vellum. Dr. C. C. Garrard, chairman of the Organising Committee, in making the presentation, referred to Sir Harry's unique achievement in being at one and the same time the head of the largest electrical manufacturing organisation in the British Empire, president of the Institution of Electrical Engineers, and chairman of the British Electrical and Allied Manufacturers' Association.

Obituary

E. J. DAVIDSON.

We record with great regret the death of Mr. E. J. Davidson, who passed away on April 24, after a long illness. Mr. Davidson, who was associated with the Electricity Supply Board in Dublin, was an I.E.S. member of long standing on whom the distinction of Fellowship had been recently conferred. He had long and intimate experience of illuminating engineering, and was one of those most actively interested in the formation, before the war, of an I.E.S. Group in Eire, where he will be greatly missed.

Street Lighting and Street Lighting Fittings

Useful papers on the above subject were read by Mr. F. Hailstones and Mr. D. Ross before the I.E.S. Glasgow Centre on March 16, Mr. J. Lawrence presiding.

Mr. F. Hailstones, the author of the first paper, gave an informative picture of the difficulties with which gas lighting has had to contend, firstly, during the blackout and subsequently in attempting a partial restoration of street lighting.

Some of these difficulties are due to circumstances beyond the control of the Lighting Authority. For good results calorific value and pressure of gas should remain constant; yet, unless the Lighting Department and the Gas Department are units of the same Corporation or Company the Lighting Department may have no control over these two factors.

Many circumstances affect calorific value in war-time. The need for conserving transport made it necessary for coal to be taken from the pits nearest to the works, which might not be suitable for gas-making. In war-time the extraction of certain important by-products is compulsory, with the result that gas suffers in quality and tends to cause "gumming" in the mains and services, clogging the action of cocks and fittings and even, in extreme cases, obstructing supply pipes. Gas pressures are likewise affected by war conditions; plants adequate for peace-time needs were taxed to the uttermost, with consequent reduction in pressure.

The change-over to 0.0002 ft.c. conversion units caused little difficulty, beyond finding the labour. The reversion to modified ("dim-out") street lighting, however, was attended by many difficulties, especially for Authorities who had not provided black-out lighting and had to get lamps into use again. In many lanterns four new glass plates had to be fitted, and stocks of glass were unequal to the demand. Trouble was experienced in getting new parts for burners, which in some cases were not of a modern type, being neither efficient, capable of adjustment, nor easy to maintain—and makers of them had sometimes ceased to manufacture. Dim-out conditions were satisfied when bijou mantles, in conjunction with restricting painting of the lantern panes to cut off upward light, satisfied dim-out conditions, and were therefore in great demand, which stocks were inadequate to meet.

Mr. Stewart, in his address in the 1943-44 Session, emphasised the need for upkeep and maintenance during the black-out. Lamps stored for five years in sheds without heat and open to the atmosphere suffer many ills, including corrosion. Mr. Hailstones gave an account of the various awkward tasks involved in making corroded Bijou burners serviceable. He also mentioned one unexpected and rather curious difficulty—that a single Bijou mantle, whilst sufficient to give the permitted illumination sometimes would not heat the lantern properly, with the result that condensation took place. One remedy was to add another mantle, but to increase the density of the paint so that the increased light would not be apparent at the foot of the standard.

In the latter part of his paper Mr. Hailstones dealt similarly with troubles that had arisen through deterioration in clock controllers, comet ignition devices, etc. In conclusion, he emphasised strongly the benefits of standardisation, advocating uniformity in types and pitches of thread on mantle nozzles, of

which, in present circumstances a great variety has to be kept in stock.

Mr. D. Ross then dealt with electric lighting.

Reviewing post-war developments, he put in a plea not only for good visibility but uniformity, blending with local amenities. The wide variations in types of fittings could be avoided by careful planning. Cheeseparing policies of some local authorities have been responsible for much of the existing chaos. On the other hand, lighting engineers have been inclined to concentrate solely on illumination, neglecting such important matters as erection, maintenance operation, control and supply systems.

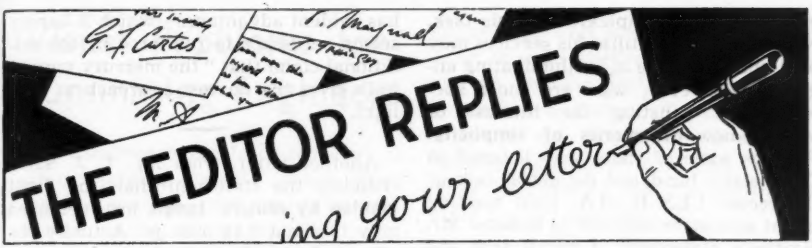
The Street Lighting Report of 1937 gave some idea of requirements in order to obtain good visibility on the roads, and if these recommendations were carried out a high standard would be reached. It is not realised, however, how many are the problems which cause lighting engineers to deviate from ideal planning. Amongst such items the author mentioned the use of standards serving trams or trolley-buses to carry street lighting units; the presence of trees, underground cables, gas and water pipes, telephone conduits, and other obstructions, which often prevent the erection of standards in the desired positions. It was also remarked that the additional central illumination, recommended on roads more than 40 ft. wide, can only be achieved if traffic islands are available or overhead spans erected, the capital cost of which may prove prohibitive. Matters are much easier, however, if such illumination is planned *when roads are under construction*. Co-operation between lighting and road accidents is likewise necessary when road surface materials are selected; many road surfaces (such as asphalt and tar macadam and, to some extent, stone sets) undergo changes in time, converting the original well diffused effect into a very streaky and patchy one.

Looking to the future the authors thought most installations will depend on tungsten lamps, at least in the initial period. Discharge lighting, greatly developed before the war, brings with it some complexities, e.g., attention to power factor, precautions against effect of high initial loading, etc. Fluorescent tubes do not seem suitable for ordinary street lighting in their present form. Sodium lamps (the colour of which is not readily corrected) should, perhaps, be confined to main roads, where their high efficiency is most valuable.

Wartime experience may influence the design of fittings, e.g., by the application of light aluminium alloys for metal work. Prismatic glass might be more widely used; the prismatic surface should, however, always be on the *inside*. Access to the lantern, allowance for ventilation, shock absorption devices for units mounted on trolley systems, etc., deserve consideration.

In conclusion the author exhibited specimens of standards, brackets, and other equipment, pointing out possible weaknesses and desirable precautions. Steel may be scarce after the war and reinforced concrete more widely used: over a period of, say, 15 years the "all in" costs are substantially the same. Unsightly overhead spans should be avoided and underground cable systems introduced wherever possible in post-war planning. Pilot cores may be included in the distribution system with advantage. The running costs, either with the cascade or impulse system, are low. In Paisley the "Cascade" system has given complete satisfaction.

Following the lecture the opportunity was taken to examine the various exhibits in the Lighting Department arranged by Mr. Hale, to whom and to Mr. E. J. Stewart a cordial vote of thanks was passed.



It seems that our **old friend the foot-candle,** which has served us well for many years, is now becoming unfashionable. In delivering his recent I.E.S. paper, Dr. Walsh remarked with some satisfaction that this term did not occur, being replaced by its more up-to-date equivalent, the "lumen per square foot." The substitution of this term in the I.E.S. Code has even been suggested.

Personally I am not at all convinced of the expediency of throwing over this familiar term and substituting another which, whilst possibly more scientific, is cumbrous and certainly less familiar. In addition, I have always found it easiest to approach the lumen by way of the candle and the foot-candle, rather than the reverse process.

One can give the beginner no visual conception of the lumen, but he *does* readily grasp **the concrete conception of the candle-power**—not so very far removed from the light yielded by the familiar wax candle. The illumination derived one foot away and the definition of the lumen as the flux corresponding to the provision of this illumination over one square foot can follow; and, if elementary mathematical knowledge in regard to the sphere is assumed, the production of 4π lumens from one candle—or alternatively the division of the lumen output by 4π in order to obtain the mean spherical candle-power—are not difficult to demonstrate. The difficulty is much greater, however, when one starts with a unit of which there is no concrete visible image.

"The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers." These words appear at the head of I.E.S. papers printed for sessional meetings, and they are usually to be found in italics somewhere in each issue of the Transactions. What is implied here in regard to the Society surely applies with even greater precision to a journal such as *Light and Lighting*, which furnishes a forum for the ventilation of ideas but naturally cannot guarantee their accuracy.

I emphasise this point because I have been taken to task for a statement quoted from Mr. Hartley's recent paper before the I.E.S. Manchester Centre (*Light and Lighting*, March, 1945, p. 34): **"Too much fuss is made about the skill and knowledge required for designing a lighting installation."**

I picked this remark out because it seemed an expression of views sure to provoke comment. It should certainly not be regarded as the viewpoint of the I.E.S., nor of this journal, and was probably intended by the author to be provocative and to excite discussion and disagreement—which, I gather, it did.

This being said, let it be also noted that few successful provocative statements are without a grain of truth. **Industrial lighting,** for example, **does sometimes present knotty problems;** but if it consisted entirely of such problems, instead of being, to a great extent, clear sailing, no practising illuminating engineer would have got through his day's work during the past years of pressure.

The viewpoint of the illuminating engineer differs materially from that of an architect or electrical contractor. Like all specialists he is sometimes prone to

exaggerate the complexities of his task, whilst those who utilise his services may well underestimate it. Illuminating engineers, however, who are most successful in enlisting the interest of others know **the merits of simplicity.** Perhaps some of those who listened to Dr. Walsh's lucid and delightful talk at the recent I.E.S.-R.I.B.A. joint meeting might almost be inclined to endorse Mr. Hartley's statement. I recall that the I.E.S. had once an amusing informal debate on the motion "That the consumer is always right." Possibly **an instructive debate** on the motion **"That the designing of a lighting installation is a simple matter"** might prove equally instructive.

Mr. Chubb's recent paper on mine lighting, delivered to the I.E.S. Newcastle Centre (*Light and Lighting*, April 1, 1945, p. 47), has brought me some letters. Dr. Nelson sends me a copy of a leaflet issued by John Davis and Son (Derby), in which the M-L **pneumatic electric lamp** is illustrated and described. This 40-watt mercury vapour lamp, yielding 1,300 to 1,400 lumens, is fed by a turbo-alternator driven by compressed air. It has evident advantages—which it hardly seems necessary to reinforce by the additional claim that "the mercury vapour bulb gives the nearest approach to daylight."

Another letter, from Mr. T. J. Sack, criticises the statement that the **light yielded by miners' lamps** has increased only to about 0.75 m.s.c.p. Actually the efforts of manufacturers have, during recent years, achieved a 400 per cent. increase in the light output. Since 1936 only lamps approved by the Mines Department have been permitted for use underground, and Mr. Sack mentions four of the most common type covered by B.S.535/1938. Two 2.5 v. lamps furnish respectively 28.1 and 32.8 lumens (2.24 and 2.6 m.s.c.p.), whilst two 4-volt v. types yield respectively 25.5 and 38 lumens (2.4 and 3.03 m.s.c.p.). The introduction of krypton-filled bulbs before the war resulted in an increase of 20 per cent. beyond these figures, and though krypton has not been available during the war period the sources of supply should now be reopened. The illumination in collieries is admittedly poor enough, but, as Mr. Sack says, one should not overlook the fact that progress has been achieved.

Fluorescent Lighting in Manchester

In their works at Upper Brook-street, Manchester, William Arnold, Ltd., have through their own electrical staff, carried out a new lighting installation, planned by B.T.H. Lighting Engineers. This installation of 72 points utilises 80 watt 5 ft. fluorescent lamps in continuous trough fittings mounted at 12 ft. above floor level on 12½ ft. centres, and is designed for a service intensity of 12-15 foot-candles.

Visual Problems for Illuminating Engineers

An excellent example of the kind of lecture lighting experts desire from those conversant with the eye was afforded by Dr. W. D. Wright's recent talk to the I.E.S. Birmingham Centre.

After a brief description of the chief parts of the eye concerned with vision, and their functions, Dr. Wright put to his audience and attempted to answer four searching problems.

Why does Vision deteriorate in Poor Illumination?

This question goes to the root of illuminating engineering. Dr. Wright recognised at least four contributory effects. The enlargement of the pupil at low illuminations—most frequently quoted—acts in the same manner as a larger stop on a camera lens, increasing optical errors and impairing definition. Next the brightness discrimination also becomes less—though we do not yet know exactly *why* this should be so. More diffuse response from the retina—responses being "integrated" over the retinal area at low illuminations—also tend to poorer visual acuity. Finally, slower response of the receptors may lead to blurring of images. On all these points, however, there seems room for physiological experimental research.

Why do we suffer from Eyestrain in Bad Lighting?

Another searching question. It is to be inferred that the strain arises through muscular activity and not retinal activity. If, due to bad lighting, acuity is poorer, work has to be held nearer and more accommodation exerted. At unduly low illuminations the healthy balance between accommodation and convergence is apt to be disturbed. Small oscillatory and twittering movements of the eyes are accentuated by the effort to secure better fixation and definition.* Similar fluctuations in accommodation may occur. A more detailed study of eye movements under bad lighting conditions—not only unduly weak illumination but the presence of glare is very desirable.

Why do Differently Coloured Objects (e.g., Coloured Signs) appear at Varying Distances, according to their Colour?

In this connection two factors were noted; the visual axis and the optical axis not being coincident and the pupil being accentric in the eye. The former (chromatic aberration) causes blue to appear farther than red. The latter causes blue to appear more distant if pupils are displaced temporarily, but nearer if displaced nasally.

Does Colour Blindness matter to Illuminating Engineers?

After dealing generally with possible causes of colour blindness and their effect on colour discrimination, Dr. Wright admitted that colour-blindness must prove a handicap, e.g., in causing erroneous photometric measurements in comparing sources of light differing in colour, in giving rise to abnormal aesthetic judgments, and in causing confusion in the interpretation of traffic lights and other means of distinction based on colour.

[*It is a peculiar thing that although, by the law of averages, there should, apparently, be quite a number of colour-blind members in the I.E.S. ranks, I can only recall hearing of one authentic case. Can it be that colour-blind people instinctively avoid this profession?*—Ed.]

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* Miners' nystagmus is presumably an acute case of such movements?—Ed.

Electricity is turning night-life into light life

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